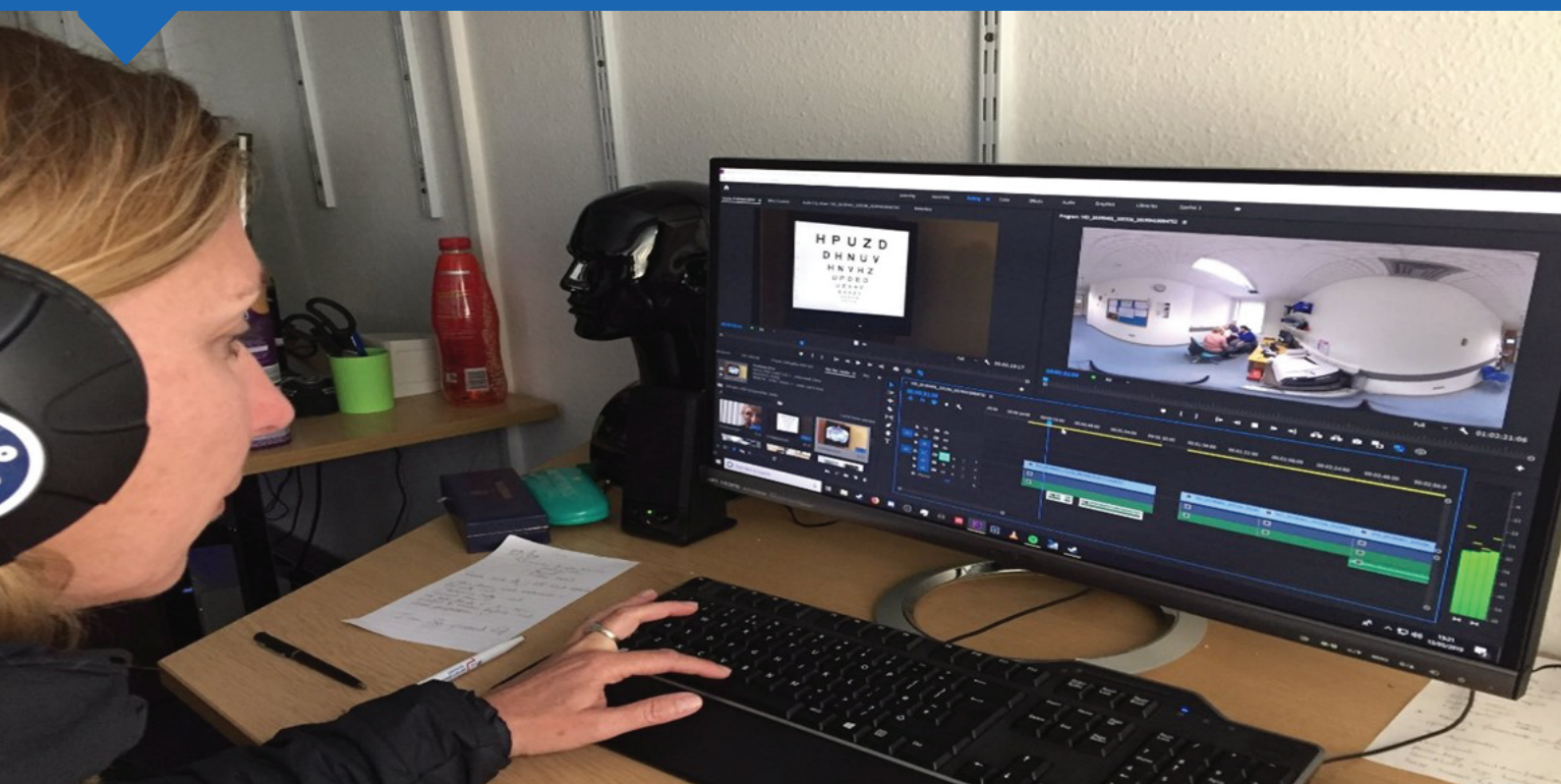# National toolkit to support the use of simulation in health and care: How to develop a virtual reality 360-degree film - part one

By Health Education England Technology Enhanced Learning

Editing software in use to edit one of the HEE allied health professional 360 films

Last reviewed July 2022

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Contents

Purpose

This guidance forms part of the Health Education England (HEE) National Simulation in Health and Care toolkit. It has been produced to help those of you who are interested in developing your interests in virtual reality (VR) further and was kindly prepared by Nick Peres, who is Head of Digital Technologies and Lead at the VR Lab in Torbay – part of Torbay and South Devon NHS Foundation Trust – which has been supported by HEE's Technology Enhanced Learning (TEL) team.

We are extremely grateful to Nick for sharing his extensive expertise and knowledge in immersive technologies, without which, the development of this guidance would not have been possible. Part two is in preparation and will give more information about post-production process.

TEL welcomes your feedback on this document, so please contact: tel@hee.nhs.uk.

Introduction

Interest in immersive technologies is growing at a rapid rate, even more so following the COVID-19 pandemic. As a result, HEE formed a Special Interest Group on immersive technologies, with the aim of delivering a framework for delivery, as well as additional elements of the simulation in health and care toolkit, to which this guidance is aligned. A second guidance document will follow, as the toolkit begins to grow.

1. Get involved

So you have seen some 360 degree content online or in a VR headset and now want to try creating your own. With the price of consumer cameras starting at a couple of hundred pounds and with some basic guidelines of best practices in place, now is the perfect time to begin exploring how this medium could be useful to you and your ideas. Maybe it is a simulation you want to record, or a patient journey scenario, a virtual tour around a building or simply to show viewers an otherwise difficult to access environment.

This guide will help you through what you need to consider before filming; how to go about filming immersive content; things to think about when stitching your footage, and how to edit.

Before you begin, the bare minimum needed to begin producing 360 degree films isn't too dissimilar from regular film or video production. You'll need:

A. 360 degree camera (different types outlined below)

B. Suitable camera support rig (though best to avoid a traditional camera tripod, so instead consider a light stand or specialist 360 support system) and

C. Means for storing your footage – plenty of hard drive space would be useful.

2. What is 360 filming?

- 360 films are created by using synchronised footage captured on multiple lenses or cameras to create a sphere of video footage which covers the entire 'field of view' (FoV).

- 360 films are often viewed using VR headsets but it is important to note that these can also be watched on mobile phones, tablets or conventional computer screens whereby the viewer would move their device, swipe the screen, or click and drag to rotate the video. When all of the above ways to view are considered, 360 videos quickly become a more accessible medium than what one might otherwise think.

- 360 films offer an immersive way of viewing an experience, allowing the viewer to explore the scene around them, and with some cameras, this can even be filmed in 3D to add further to the viewer's sense of engagement.

- 360 films can also be made to be interactive, using software to build 'hotspots' which are points within the video that allow the viewer to engage in other media material (such as jumping from a 360 degree video to another 360 degree video through a doorway or bringing up an information tab). For an example of these types of interactions, please check out the HEE Allied Health Professional Day in The Life Of video series https://hee-vr360.azurewebsites.net/

3.   How to make a VR360 film (simulation toolkit)

3. Different types of 360 camera

Single lens cameras

The simplest, but least common type of camera for capturing 360 video footage, is one which has just a single lens. The lens is highly rounded or dome like and referred to as a 'fisheye'. Fisheye lenses vary in their FoV, i.e. how much can be captured in one go, but some offer extreme FoV that can be leveraged for 360/VR applications. NOTE: no current fisheye lens can capture the entire 360 image which is why this approach isn't popular. The resulting footage will always have a black area at the top (zenith) or bottom (nadir) of the video footage sphere.

Back-to-back

The next simplest type of 360 camera and the most common amongst consumers/prosumers is a two lens back-to-back camera, and this works through two fisheye lenses. This ensures full coverage but introduces the need to join and synchronise the two video feeds - this process is called 'stitching'. Most modern back-to-back cameras feature an auto stitch process while shooting (though stitching in post-production can often render better results) making these types of cameras the most accessible and useful to start 360 video production. The most modern of these cameras (such as the Insta360 ONE X2 or GoPro Max) can achieve good resolutions and often due to the smaller size of these types of camera do make it easier to set up and use in reduced spaces. The majority of these cameras can also be controlled remotely using a mobile phone app, which is a great way to stay hidden from the action.

A Yi360 camera being used to film a 'Stop before you block' training scenario at Torbay and South Devon NHS Foundation Trust (TSDFT)

Multi-lens

As we add more lenses each is required to capture less of the total scene. This means each individual portion of the video sphere can be of higher quality, with less distortion at the edge of the frame, but with increased complexity required in the stitching process, more 'stitch lines' (i.e. areas where two lenses overlap in their contribution to the final video sphere), and more data to collect and process.

Another common advantage of multi-lens 360 cameras is they can capture footage at higher resolutions and in 3D via a slightly different view point of the scene being captured simultaneously to allow for both a left eye and right eye perspective. A higher resolution will give a more comfortable experience to the viewer (particularly in VR) but be warned, the file sizes you will experience from shooting with six lenses, like the below Insta360 Pro2, will mean big hard drive space needed and a pretty powerful system for any post-production stitching.

The Insta360 Pro2 has six lenses and a friendly robot face

Multi-camera rigs

Similar to multi-lens 360 cameras where each lens serves a video sensor and results in an individual video file for each; multi-camera 360 rigs do the same, but each camera is completely autonomous. This is how 360 video footage was captured during the earlier days of 360 filming and has become much less common today. Many hours have been spent, and sometimes lost, stitching from these cameras – however it was a good way to learn the good, bad and ugly side of 360 production!

GoPro camera rig being used for recording training simulations at TSDFT

As previously mentioned, some multi-lens cameras capture sufficient information per lens/camera to cover both a left eye and right eye view of a scene at the same time (and 3D is an option often selectable as a recording format on the camera). It is worth noting that filming in 3D has both plus and negatives, but there is one benefit even if you are not planning for the viewer to see the final footage in 3D. This is because the overlap between the individual lenses is greater which typically eases the stitching process and results in better looking end results.

VR180

An often-overlooked format and one that has struggled to gain real traction, despite some fanfare and earlier pushes through social media platforms, is VR180 or 180-degree stereoscopic video. This is the process of using two fisheye lenses mounted side-by-side instead of back-to-back such that the final content can be viewed in 3D and capturing a wider image, but the coverage is limited to a 180-degree field-of-view. Whilst it can initially be easy to dismiss this format as being less immersive, the resultant 3D effect is typically more realistic, and due to the close proximity of the two lenses, it is possible to get much closer to the subject you are filming without running into 'parallax' issues when stitching. This format proved useful for recording perspective-based work, where capturing a point of view would benefit from a wider image and where a 360 camera would not be suitable – the extra width of the image offering much to consider around the point of view periphery. This format however, as alluded to, has struggled for uptake with some camera manufacturers pulling out of this market.
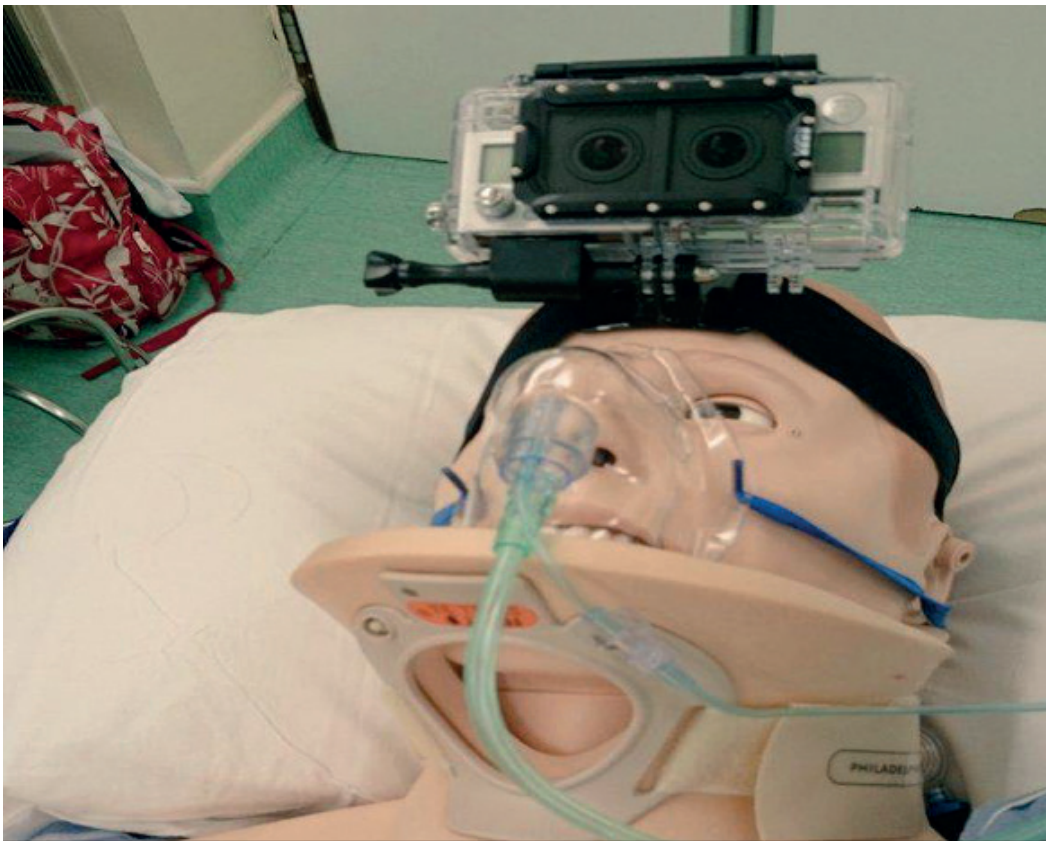
Simman enjoying wearing a side-by-side GoPro 3D rig for perspective video

4. What about sound?

Stereo

The simplest form of audio track in VR and 360 films is the familiar stereo track where a separate, synchronised, audio track is played to the viewer in each of their ears. This will be a familiar method to those who are involved in video production. The limitation of this approach is that as the viewer turns their head in the VR headset they instinctively expect the sound to adjust accordingly - for example, if they were to turn 180 degrees and nothing in the scene they are viewing has physically moved, they instinctively expect what they were previously hearing in their right ear to now be in their left ear and vice versa.

Ambisonics

Ambisonics is a full-sphere surround sound format: in addition to the horizontal plane, it covers sound sources above and below the listener. Ambisonics is a method for recording, mixing and playing back three-dimensional 360-degree audio. This allows VR content producers to give their audience an experience whereby the audio matches what they're seeing; with both adjusting in line with the direction the viewer is looking. Some modern 360 cameras have on-board or 'built in' 360 audio recording capability, which is useful for quick content capture but may not have the quality desired versus using a dedicated microphone, such as the Zoom H3-VR audio recorder. This process, though more immersive for the final experience, can take a bit of extra time to get right.

> "The basic approach of Ambisonics is to treat an audio scene as a full 360 degree sphere of sound coming from different directions around a centre point. The centre point is where the microphone is placed while recording" – a good breakdown explanation of this can be found here: https://www.waves.com/ambisonics-explained-guide-for-sound-engineers .

Insta360 Pro with a Zoom H3 audio recorder mounted as a 'hat'

Other audio sources

In addition to capturing audio from the scene, you may want to think about other ways you are planning to incorporate audio for the experience, and whether this will be done at a later stage, such as recording a stereo voiceover for narration.

5. So, what does it all mean for video production?

- More immersive content (when shot right)

- Capturing previously missed or unseen things

- New technical considerations throughout the production process

- New challenges

- New opportunities

- Lots of things for us all to learn.

There can be many points to consider when capturing VR 360 video footage (some examples are listed below) but the most important thing when getting started is to keep things simple, concise and relevant.

Patient perspective captured for communication training during COVID-19 simulation

- Whose perspective or point of view do you want your audience to take?

- How long can you expect to hold your audience's attention? (think about duration of the scene and comfort – is the camera going to be still and positioned well?)

- Is there a specific lesson, insight or key outcome you need your viewers to learn/discover?

- Is your story best told in a single linear thread, or do you want your viewers to arrive at different outcomes depending on choices they make? This might be particularly useful if you are encouraging a debrief element.

- Where do you want your audience to look and how will you help direct that attention in the 360 space?

- What camera and audio settings to use.

5. With simplicity in mind, why not start by following these simple considerations for filming:

Keep the camera stable

- Whilst newer 360 cameras offer incredible image stabilisation, 360 video arguably works best when you simply place the viewer into a specific location/scenario and let them observe. Fast camera movement can work negatively through two main reasons. 1) it isn't often comfortable for viewers watching moving, fast paced content using VR headsets, so think about comfort for your audience 2) it can distract the viewer, not giving them opportunity to explore and this often causes lower levels of immersion (agency removal) when they are concentrating just on the action in front of them.

- A support system/stand will also help those in front of the camera to concentrate on the environment and activities by not getting too distracted from a moving or intrusive camera, which will yield a better performance from them.

- A traditional video tripod isn't the most suitable way of stabilising the camera due to how wide the tripod legs spread, which isn't attractive to look at in the 360 footage. Instead consider a solid duty lighting stand or a specialist 360 support system, like the Manfrotto range (https://www.manfrotto.com/uk-en/collections/supports/360-virtual-reality/) that have a differently positioned way of using legs to act as a tripod.

Using a heavy-duty light stand makes it easier to cover up the legs in the edit as they are positioned further down versus a normal video tripod

Position the camera at eye level

Typically it is best to set the view point at the most natural position possible. If you elect to play with this rule it is best to go higher (becoming observational) rather than lower with the camera positioning. For lower camera angles, be aware that positioning the camera down low may make some viewers feel uncomfortable, intimidated, or simply prevent them from paying attention to the action and information you are trying to share with them. By meeting eye level with the camera, you create an engaging and more natural way for the viewer to associate themselves within the immersive content, the camera taking on a perspective that meets eye contact, etc. Again, think carefully about comfort for your audience.

High camera positioning tends to give a 'fly on the wall' perspective which can be useful for enabling the viewer to see a summary of all of the action (for example, observing a medical simulation), but this typically reduces both the sense of engagement with those in the scene and detracts from the emotional and narrative connection. Think about what you want to achieve and if you desire your audience to feel like they are part of the story or whether you are wishing just to capture a lot of activity. A helpful tip for immersion; treat the camera as a person or as another observer in that scenario.

Make sure the scene is set to maximise the 360 environment

Even when the majority of content takes place within 180 degrees (for example, for some medical training practice or simulation scenarios focused primarily on activities around the manikin) try and position the camera in the position of an observer involved in the scene and position things like trays, equipment or other things sensibly distanced around the camera. Add interest and even occasional interaction around the space to utilise 360 degrees (perhaps a fleeting interaction) but be aware of making the whole space too busy throughout, as this will be too much for the viewer to digest and take in, and detract from any main learning points.

When shooting think about the perspective you want. The camera for the most part should be considered as a person observing the scene as closely as possible (an invisible participant).

The camera can also be put into first person using a head mount or having the actors/participants talk directly to the camera can be a very powerful way of involving the viewer – but keeping the camera as stable as possible for this is very important for post viewing comfort.

Don't position interactions and objects too close to the camera. Due to parallax issues (making it difficult to have a clean stitch between lenses) as well as feeling like an invasion of personal space (even the virtual space for your audience) it is good practice to leave some room around the camera, enhancing both the user experience and maximising the visual area of what the camera is capturing (more on this below, but treat the immediate area around the camera area as a minimal or even no go space).

Positioning the camera to capture the main activity but leaving room for movement and 'safe space'

7. Planning your scene

A good way to place the camera and map activity from it is to use a combination of storyboards and a bullseye diagram with circled areas that describe the camera's position, a no go safe zone, a main activity area and then spanning out to a viewer's peripheral vision. Imagine this mapped out on the floor from the position of the camera, or in pre-production, draw this out for each scene to help consider the following:

Minimum stitching distance (no go zone)

An important circle to draw or visualise on the diagram is the distance away from the camera that objects must be to avoid parallax issues with stitching or getting too close to feel like someone's 'virtual' personal space. The specifications for every 360 camera should indicate what distance this is, and the distance will vary for when objects are directly in front of a lens, versus being between them (i.e. on a stitch line). Try and perform your own tests to find this out and see the result. In my experience, a rule of thumb would be a minimum of 60cm away from the camera.

Initial Field of View (FoV)

Which direction should the camera's main lens face? Whilst this can be adjusted in post-production in a process called 'offset', it is better to film with the camera 'pointing' in the direction you want the viewer to be shown at the start of the scene.

Intended FoV

For very structured or planned films, if the intention is for the viewer to follow specific action that is moving in the scene, or for them to change the direction they are looking before the scene is 'cut', a main FoV area could be shown on the bullseye diagram using lines that demonstrate the main area being captured outward from the central camera point. This could also be detailed in any storyboarding using movement lines of actors or objects of attention. For very natural observational 360 video (i.e. where you would want to record a scenario as normal to everyday practice as possible) this amount of detail is likely not be required. Just be sure to place the camera in a safe (so it doesn't get knocked) but useful point in the scene.

Object and character movement

Again, for the more structured approach to certain types of 360 films, it is useful in pre-production to name actors in storyboards using their on-screen character names. Actors should be shown in plain view with arrows indicating the path of any movement they make throughout the scene. The arrows should show the full extent of their movement rather than a general indication of the direction they will set off in (there is no stage exit left or right in 360). This isn't necessary for observational filming.

Light sources

The position of all light sources and their type (i.e. sunlight, lamp, strip light, etc.) could be plotted on the bullseye diagram and within any storyboards – particularly artificial/deliberately placed ones. If the scene is already well lit or if you wish to keep it authentic, it is often best to work with the current environment or natural lighting to avoid introducing other elements that might be difficult to hide in 360.

Previewing the image - connect your phone/device and see what the camera sees

- Most 360 cameras will allow you to preview what the camera is seeing using a companion app on your phone or other smart device such as a tablet. Once you have physically set everything up, take time to check how things actually look to the camera. The first thing to double check is the three points above re: camera positioning. Scroll around your footage to check everything looks stable, level, and free from stitch lines crossing faces, objects or other key areas within the scene.

- This is also a good opportunity to check how big/small your actors look in the scene. Think about how intimate you need your 360 experience to be to the viewer and be confident in taking the time to move the camera or actors until you get this right. This is one thing you cannot 'fix in post' with 360 footage.

- Check the lighting - is the sky, or areas around overhead lighting, windows, etc. completely burnt out? This might be affected by how close a camera is positioned to that light. Some companion apps will let you correct and change the exposure of the scene.

Remote viewing preview of footage also allows others to see the shot

8. Directing your scene

Direct your talent

- Remind those being filmed what you want them to do, and how long you want it to take. Describe the intention or walk them through it and let them practice if need be. Consider this more like theatre than traditional filmmaking (unless you are a budding Mike Leigh) as you'll typically be capturing longer scenes than traditional filmmaking. As a 360 filmmaker, you will need to be away from the scene while filming takes place (or risk being seen) so be prepared to talk through the activity before you begin filming.

- Encourage those you are filming not to look directly into the camera unless the storyline specifically calls for that sort of interaction or camera perspective with the viewer – remember this is a powerful mechanism of engagement, but unless this is otherwise part of the narrative this can detract the viewer from the more observational nature of 360 degree content – such as recording a simulation or career shadowing film.

- If you are planning to create quite a structured film, guide your talent on the extremes of how close and how far you want them to be from the camera by giving them physical and visual references for these points if any such options exist in your scene. For example, don't go past that chair to the left of camera, or don't lean back past the windowsill.

Go hide

- 360 cameras see everything! This means you need to make sure you, and anyone else you don't want in the film are well hidden - ideally out of the room (though I have hidden under beds, behind pillars and even acted as an extra in scenes in order to help direct).

- Removing unwanted objects or blurring sensitive information is possible later on, but this can be time-consuming and can easily be avoided by checking your scene properly first. Best to get it right during filming rather than trying to fix in the edit.

Shout 'ACTION!'

- Shouting action or clapping your hands might feel cliché but genuinely is really helpful, as it not only tells everyone the camera is filming and the scene should begin, but is a useful point to help synchronise the audio and video in the edit (if the two have been separately recorded). A useful tip; count to five before doing so. You can always cut off this part of the footage in the edit, but it allows time for everyone to settle and focus right before the scene begins.

- If you are filming more than one scene or scenario during the shoot, it is also worthwhile saying or showing on a piece of paper (or clapper board if you have one) the scene and shot number before commencing the action. This tends to be for more advanced shoots or long days where shot logging multiple scenes will aid the post-production process, but it is a good practice to get into.

- During the take, use the preview mode on your phone or other device to keep an eye on the action as best you can. This isn't always possible as playback can sometimes be slow/juttery or delayed but you might spot something that requires you to call a halt to proceedings before the whole scene/shot has played out, and noticing this early can save a lot of time and frustration. It is also a good way to share what is being filmed with others involved in the project to make sure what is being captured is accurate. It is also a great way to help explain how 360 video works (there is always lots of interested people who want to engage).

Live previewing the filming from a different room with the AHP occupational therapy team

Shout 'CUT!'

Again, it is important to make it clear when footage is being captured and these start and stop instructions give confidence and organisation on set, but in practical terms it also means anyone hiding knows when they can move again without fear of appearing in shot.

Review your footage before moving on.

It is always better to double check and film again than assume you have got what you need.

Review your footage before moving on. It is always better to double check and film again than assume you have got what you need.

Check your recording format and camera settings

- Record at the highest resolution possible in order to maximise quality for the viewer when watching back (5.7k resolution is currently the top spec on double lens cameras). This is particularly important for details in a film but also the higher the quality you can achieve, the better and more comfortable the experience for those watching it using VR headsets.

- Some cameras have an auto stitch function, which means the camera will stitch the images from the lenses together, meaning you have a 360 video created relatively quickly and ready to go. This is useful for footage which requires a quick response (perhaps you are filming a scenario that you would like to use in a debrief soon afterwards, or a live viewing of an event). However, an auto stitch will often be an option with a reduced resolution on the camera, or, as often is the case, the stitch will not be as neat or accurate as what it would be if done in the post-production phase. So think about the purpose of your 360 films – is it for quick review or prototyping, where the ease and speed of an auto stitch is more important than the quality, or is this a film that you can go into more detail and time with, that requires some post production work?

- [ADVANCED] Check what 'white balance' setting you are using. Auto is fine in many cases but look at peoples' faces, and the colour of white objects in the scene. If there is a bias towards any colour then manually choose a white balance setting to match the most dominant light source in the scene.

- [ADVANCED] Keep your ISO level to the lowest possible without the scene becoming dark or motion becoming blurred.

- [ADVANCED] If you have control over shutter speed, make sure it is one over twice the FPS setting - e.g. 1/50th for UK when filming at 25FPS, or 1/100th for 50FPS.

Hopefully some of these tips will be helpful for you to begin your own exciting 360 content journey. You may like to start with familiarising yourself with 360 video by utilising your camera's auto functions to get a feel of the process, and if you are using auto-stitch or your smartphone to stitch and do some basic editing you can begin sharing your experiences quite quickly.

In part two of the guide, we will delve into the process of post-production and talk about the software and options you have to enhance your 360 films further – even making them interactive.

For more information or if you have any questions about VR 360 degree filming, please contact: simimmtech@hee.nhs.uk.